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## Low-Cost Digital Lock-In Amplification and Resonance-Tracking

A low cost method for implementing digital Lock-In Amplification and resonance tracking utilizing a Xilinx Field Programmable Gate Array (FPGA) is presented. Many types of Scanning Probe Microscopy (SPM) employ some form of probe resonance tracking, either for improved sensitivity, or as an additional probing measurement. Implementing these systems digitally through the use of an FPGA affords exceptional reconfigurability, repeatability, and debugging capabilities. However, the relatively high cost of Commercial Off The Shelf (COTS) digital SPM systems may be out of reach for a large number of research groups. The method presented here, consisting of a Xilinx Zynq Ultrascale FPGA, open-source motherboard, and in-house, 10Msps input, 1 Msps output modular analog I/O board can be built at a much lower cost without any sacrifice to equivalent FPGA slice counts or I/O sample rates, as compared to a typical COTS system. This method is demonstrated by use with a Near-Field Acoustic Microscope.

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